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Bilateral versus Multilateral Free Trade Agreements: A Welfare Analysis*

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Abstract

Why do we observe proliferation of bilateral free trade agreements (FTAs) between certain types of countries instead of having progress in attaining global free trade through a multilateral FTA? We answer this question by exploring the enforceability of different types of FTAs through comparing minimum discount factors that are necessary to sustain them in an infinitely repeated game framework. We also search for the globally welfare maximizing trade agreements that are sustainable under different conditions. The results depict that transportation costs, differences in country sizes and comparative advantages are all obstacles for having a multilateral FTA. Accordingly, international development policies conducted for the removal of such obstacles should be the main goal toward achieving a multilateral FTA, which we show to be the first-best solution to the maximization problem of global welfare.

JEL Classification: C72; C73; D60; F15

Key Words: Free Trade Agreements; Self-Enforcing Rules; Transportation Costs; Country Size; Comparative Advantage; Repeated Game

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1. Introduction

The lack of a forcing authority in trade relations of world countries makes it difficult to achieve a multilateral free trade agreement (FTA) that increases world welfare. This creates a structural problem of rules in trade agreements that will self-enforce the trading countries to achieve more liberal trade. In this paper, we study these self-enforcing rules with asymmetric countries from the perspective of bilateral and multilateral FTAs. In particular, we attempt to find an answer to the question of "Why are FTAs bilateral/regional/preferential rather than multilateral?" Before we can answer this question, since many trade models find a multilateral FTA to be the first-best solution, we need to know why bilateral FTAs exist in the first place. To better understand the characteristics of bilateral FTAs, consider Baier and Bergstrand (2004) who empirically find that the potential welfare gains and likelihood of a bilateral FTA are economically and significantly higher: (i) the closer in distance are two trading partners; (ii) the more remote a natural pair is from the rest of the world (ROW); (iii) the larger and more similar economically (i.e. real GDPs) are two trading partners; (iv) the greater the difference in comparative advantages; and (v) the less is the difference in comparative advantages of the member countries relative to that of the ROW.

The empirical findings of Baier and Bergstrand (2004) above are consistent with 85% of the 286 bilateral FTAs existing in 1996 among 1431 pairs of countries and 97% of the remaining 1145 pairs with no bilateral FTAs. Hence, to have credible results, any trade model investigating bilateral FTAs should be consistent with these empirical findings. We present such an N-country-N-good partial equilibrium trade model by generalizing the 2-good-2-country model in Bond and Park (2002) through considering possible interactions between country sizes, comparative advantage, and transportation costs.

For simplicity, we assume that the downward-sloped demand curve and upward-sloped supply curve of each good in each country are linear in price of the good. We show that international trade between any two countries is achieved through differences in supply and demand structures of the countries. It follows that the equilibrium autarky price (for each good) in any country depends on the individual country specific demand and supply structure, while the equilibrium price (for each good) under international trade depends on the demand and supply structures of all countries together with country-specific tariff rates and transportation costs. We let each country to receive all the tariff income for the good that the country imports. Accordingly, the national welfare is defined as the weighted sum of consumer surplus, producer surplus and tariff incomes. Using this definition in a welfare analysis, we estimate the policy weights (assigned to consumer surplus, producer surplus, and tariff income across countries) that are consistent with the empirical findings of Baier and Bergstrand (2004) regarding bilateral FTAs. The estimation results suggest that the policy weight on producer surplus is much higher than the others. Using the estimated policy weights, we investigate for the economic conditions of our model under which bilateral versus multilateral FTAs may exist with self-enforcing rules.

In order to incorporate self-enforcement agreements into the model, we allow countries to get involved in a stationary dynamic tariff game, i.e., countries play an infinitely repeated game for tariff rates. In this game, each country is able to compare future payoffs out of a possible collusion (cooperation) with future payoffs out of a possible deviation from the agreement. In order to sustain collusion in a trade agreement, the trade-off between the gains from deviating from an agreed-upon tariff policy and the discounted expected future gains from collusion must be balanced in a way that the latter should keep away countries from deviating. Within this picture, we ask the more-detailed question of this paper as "Why do we observe proliferation of bilateral FTAs between certain types of countries instead of having progress in attaining global free trade through a multilateral FTA?" We answer this question first by exploring the enforceability of different types of FTAs through comparing the minimum discount factor that is necessary to sustain them. After having such a minimum-discount-factor analysis, we go one step further by searching for globally-sustainable-Pareto-optimal trade agreements defined as the globally welfare maximizing trade agreements that are sustainable under different conditions. For the impatient reader, our results suggest that transportation costs, differences in country sizes and comparative advantages are all obstacles for having a multilateral FTA, which we show to be the globally first-best solution for several different cases of our model. Therefore, removal of such obstacles should be the main goal toward achieving a multilateral FTA. Accordingly, international development policies conducted for countries to converge to each other (e.g., increasing internal and international stability, reducing poverty, investing in transportation technology, international diffusion of production technology) should be the main tools.

Related Literature

Common questions that have been investigated in the literature are whether the trade liberalization is achieved through bilateral/preferential agreements or multilateral agreements, whether preferential agreements are building blocks or stumbling blocks for multilateral agreements, and whether bilateralism or multilateralism is a better strategy for countries. Since it is not possible to mention about all relevant studies, we will talk about a selected group of them that we think as best comparable to this paper. Bagwell and Staiger (1999) study a competing-exporters model with three countries to identify the different circumstances under which the preferential agreements can lead to multilateral agreements or block them. Other studies that investigate the relation between preferential and multilateral agreements in different settings are Bagwell and Staiger (1997a,b) (1999), Bond and Syropoulos (1995), and Bond, Syropoulos and Winters (2001). All of these studies assume that countries can commit tariff rates under preferential agreements, hence, only the multilateral agreements must be self-enforcing, which makes bilateral versus multilateral FTAs hard to compare in terms of sustainability. In our paper, preferential agreements must be self-enforcing as well in order to make such a comparison. Another study is by Limao (2007) who investigates the effects of preferential trade agreements on global free trade when countries are motivated by cooperation in non-trade issues. Limao argues that the preferential agreements motivated by cooperation in non-trade issues increase the cost of multilateral tariff reductions and, hence, decrease the likelihood of a multilateral free trade agreement. Compared to Limao, our paper finds that bilateral (compared to multilateral) FTAs are easier to sustain even in the absence of non-trade issues. Another recent study, Saggi and Yildiz (2010), focus on the comparison of bilateralism and multilateralism through trade liberalization. They employ a competing-exporters model in which tariff rates are determined endogenously. They argue that when countries have symmetric endowments, both bilateralism and multilateralism yield global free trade, but when countries are asymmetric in terms of endowments, global free trade is stable (for a large set of parameters) only through bilateral agreements.[1] This result is not consistent with the implications of our model where bilateralism is always easier to sustain compared to multilateralism in an infinitely repeated game framework; nevertheless, our paper shows that a multilateral FTA with symmetric countries (i.e., countries with similar sizes and comparative advantages in the absence of transport costs) is easier to sustain compared to a multilateral FTA with asymmetric countries (i.e., countries with different sizes and comparative advantages in the existence of transport costs).

The relation between transportation costs (i.e., geography) and trade agreements has been previously studied in the literature starting with Viner (1950) who has mentioned departures from the Most Favored Nation (MFN) principle between countries within Europe going as far back as the nineteenth century.[2] Nevertheless, instead of explaining these agreements through trade costs, Viner has reasoned them to "close ties of sentiment and interest arising out of ethnological, or cultural, or historical political affiliations". Other earlier studies such as Meade (1955) and Lipsey (1957) haven't mentioned about a possible effect of transportation costs on regional trade agreements either. Wonnacott and Wonnacott

[1] In our model, countries do not compete over the goods that they export because each country exports only one good; i.e., when two countries involve in a bilateral agreement, the non-member countries do not face discriminatory tariffs in export markets. For a futher discussion on the relationship between preferential and multilateral liberalization see also Bhagwati et al. (1999), Saggi (2006), and Karacaovali and Limao (2007).

[2] As Panagariya (2000) states, MFN is the centerpiece of the General Agreement on Tariffs and Trade (GATT) that governs the international trade in goods. In particular, MFN refers to the trade policy in which each World Trade Organization (WTO) member grants to all members the same advantage, privilege, favor, or immunity that it grants to any other country.

(1981), Wonnacott and Lutz (1989), Krugman (1991, 1993), Summers (1991), Frankel, Stein and Wei (1995), and Bhagwati and Panagariya (1996) have attempted to find whether or not proximity between countries have made regional agreements more beneficial compared to non-regional agreements. In particular, Wonnacott and Wonnacott (1981) assign an important role to transportation costs in their analysis, but their study has been criticized by Berglas (1983) and Panagariya (1998) in the sense that the transportation costs have to be too high in order to talk about the effect of transportation costs on regional trade agreements. However, in our paper, we show that even transportation costs up to 25% of source prices can have significant effects and become an obstacle for a multilateral FTA in a repeated game framework. Besides, following Krugman (1991), other studies such as Frankel (1997), Frankel, Stein and Wei (1995), Frankel and Wei (1997) have also advocated for the effect of transportation costs on regional trade agreements. However, building on the earlier critique in Bhagwati (1993) and Bhagwati and Panagariya (1996), Panagariya (1997) has shown that transportation costs are not different than any other costs and hence should not deserve any special attention in explaining the regional trade agreements. Since transportation costs are exogenous in our paper, we accept that they are not different than any other costs (e.g., standard gravity-equation costs other than tariffs, such as cultural ties or networks), but the important point we show is that they still have significant effects on the formation of FTAs.

In terms of methodology, the common question in the literature asked is whether tariff reductions with nearby partners are welfare improving. Krugman (1991), Frankel Sten and Wei (1995), and Bhagwati and Panagariya (1996) have examined this particular question by considering whether exogenously given preferential tariff reductions are welfare improving in a model where there are different levels of transport costs between trading partners. This approach has been extended by Bond (2001) through considering *self-enforcing agreements* in a four-country endowment model. In particular, Bond (2001) assumes that the world is divided into two continents, with two countries located on each continent. There is a per unit cost on any good imported from a country on the other continent, but zero transportation cost on goods coming from the country on the same continent. Bond shows that Nash equilibrium tariffs on regional trading partners are higher than those on the distant partners; one might anticipate that this fact would make it more difficult to support trade liberalization with nearby countries, because the incentive to deviate at a given agreement tariff would be higher. However, this effect is offset by the fact that the welfare level under regional free trade agreements is higher than that with a distant partner. This is because free trade agreements with distant partners have higher external tariffs against all countries, which leads to lower world welfare under distant free trade agreements. In sum, Bond (2001) shows that the equilibrium with regional trade agreements yields higher welfare. This paper follows a similar approach with Bond (2001) in terms of considering possible transport costs across countries, but our analysis differs from his paper by considering (i) an N-country-N-good model, (ii) a supply side in each country with different levels of comparative advantage and, hence, trade through the search for minimum prices, and (iii) differences in country sizes. These extensions imply different results compared to the results in Bond (2001): A multilateral FTA leads to a higher global welfare even with moderate transport costs (up to 25% of source prices), country size differences (up to three times), and comparative advantage differences (up to two times); however, a multilateral FTA is always harder to sustain compared to a bilateral FTA.

2. The Model

We consider a partial-equilibrium international trade model populated by N countries and N goods. This an extended version of the model by Bond and Park (2002) through considering transportation costs and increasing the number of countries (from 2) to N in order to investigate the formation of possible bilateral versus multilateral FTAs. The model considers asymmetries across countries in terms of their sizes, comparative advantages, and transportation costs. In terms of notation, $C = \{1, \ldots, N\}$ represents the set of countries and H_{ji} is related to variable H in terms of good $i \in \{1, ..., N\}$ in country $j \in \{1, ..., N\}$. The complete list of variables and parameters are given in Table 1 for convenience.

2.1. The Economic Environment

The demand for good i in country j is given as follows:

$$D_{ji} = \lambda_j \left(A - Bp_{ji}\right)$$

where we assume that the demand curve is downward-sloping and linear in price of the good, p_{ji} is the price of good i in country j, $\lambda_j \geq 1$ is a parameter by which we measure the relative size of country j, $A > 0$, and $B > 0$.[3] Similarly, the upward-sloping supply curve of good i in country j, which is also linear in price of the good, is given as follows:

$$X_{ji} = \lambda_j \left(\alpha_{ji} + \beta p_{ji}\right)$$

where $\alpha_{ji} \leq 0$ measures comparative advantage (i.e., a higher value of α_{ji} corresponds to a higher comparative advantage), and $\beta > 0$. Note that in a special case of $\lambda_j = 1$ for all j, we have N symmetric countries with the same size. According

[3] See Gehrels (1956-1957) and Lipsey (1957) for early theoretical models that compare the implications of zero elasticity of demand and non-zero elasticity of demand. Also see Panagariya (2000) for a recent discussion on the implications of downward-sloped demand and upward-sloped supply.

to the supply and demand functions in each country, the autarky price of good i in country j, $p_{ji}(a)$, is given by the following expression:

$$p_{ji}(a) = \frac{A - \alpha_{ji}}{\beta + B}$$

Since we assume that $A > 0$ and $\alpha_{ji} \leq 0$ for all i and j, the autarky price is positive for each good in any country, i.e., $p_{ji}(a) > 0$.

Each country can impose specific tariffs on its importables, with t_{jk} denoting the tariff rate imposed by country j for goods imported from country k (where $t_{jj} = 0$ for all j). Moreover, trade between any two countries is up to an exogenous symmetric iceberg transportation cost, with τ_{jk} denoting the cost from j to k (where $\tau_{jj} = 0$ for all j). In order to ensure that there is a single exporter of each good k, we assume that $\alpha_{kk} - \alpha_{jk} > (\beta + B)(t_{jk} + \tau_{jk})$.[4] That is, because country k is the lowest cost supplier (including trade costs) of good i for all countries (i.e., $p_{ji}(a) > p_{ki}(a) + t_{jk} + \tau_{jk}$ when $i = k$ for all $j \in C \backslash \{k\}$ where $C \backslash \{k\}$ is the set of all countries excluding country k), country k is the single exporter of good i. Therefore, when trade is achieved, we can write the price of good k in country j by the following expression:

$$\begin{aligned} p_{jk} &= \min_i \{p_{ik} + t_{ji} + \tau_{ji}\} \\ &= p_{kk} + t_{jk} + \tau_{jk} \end{aligned}$$

Note that if $j = k$, then trade costs are zero (i.e., $t_{jk} = \tau_{jk} = 0$), so that the price of the domestically produced good is $p_{kk} = p_{jk}$ in such a case.

The market clearing condition for good i can be written as follows:

$$\sum_{m=1}^{N} \lambda_m (\alpha_{mk} + \beta p_{mk}) = \sum_{m=1}^{N} \lambda_m (A - B p_{mk})$$

By using $p_{mk} = p_{kk} + t_{mk} + \tau_{mk}$ for all $m \in \{1, \ldots, N\}$, we can find the source (i.e., factory gate) price of good i in country k as follows when $i = k$:

$$p_{kk} = \frac{\sum_{m=1}^{N} \lambda_m (A - \alpha_{mk} - (\beta + B)(t_{mk} + \tau_{mk}))}{\sum_{m=1}^{N} \lambda_m (\beta + B)}$$

By the assumptions of the model introduced above, p_{kk} is positive.

The volume of the imports of country j from country k is then given by the following expression:

$$M_{jk}(p_{jk}) = \lambda_j (A - \alpha_{jk} - (B + \beta) p_{jk})$$

[4] We assume that any country k has enough supply of good k to satisfy the demand of good k in the global markets.

where

$$
\begin{aligned}
p_{jk} &= p_{kk} + t_{jk} + \tau_{jk} \\
&= \frac{\sum_{m=1}^{N} \lambda_m \left(A - \alpha_{mk}\right)}{\sum_{m=1}^{N} \lambda_m \left(\beta + B\right)} + \frac{\left(t_{jk} + \tau_{jk}\right) \sum_{m=1}^{N} \lambda_m - \sum_{m=1}^{N} \lambda_m \left(t_{mk} + \tau_{mk}\right)}{\sum_{m=1}^{N} \lambda_m} \\
&= \frac{\sum_{m=1}^{N} \lambda_m \left(\frac{A-\alpha_{mk}}{\beta+B} + t_{jk} + \tau_{jk} - t_{mk} - \tau_{mk}\right)}{\sum_{m=1}^{N} \lambda_m}
\end{aligned}
$$

Note that the derivative of p_{jk} with respect to t_{jk} or τ_{jk} is positive since $\lambda_j \geq 1$ for all j; i.e., destination prices increase in trade costs, and thus the volume of imports decreases in trade costs (and source prices) and increases in country sizes.

2.2. Optimal Tariff Rates

In order to go one step further and talk about optimal tariff rates in our analysis, we need an objective function for each country, which will be the key to our policy analysis, below. The natural choice is, for sure, the national welfare function, which is defined as the weighted sum of consumer surplus, producer surplus and tariff incomes. As in the existing literature, we let each country to receive all the tariff income for the good that the country imports. In particular, national welfare for country j is expressed as follows:

$$
W_j = \sum_k \left[WCS \int_{p_{jk}}^{A/B} D_{jk}\left(u\right) du + WPS \int_{-\alpha_{jk}/\beta}^{p_{jk}} X_{jk}\left(u\right) du \right] + WTI \sum_k t_{jk} M_{jk}(p_{jk}) \tag{2.1}
$$

where $\int_{p_{jk}}^{A/B} D_{jk}\left(u\right) du$ is the consumer surplus for good k in country j; $\int_{-\alpha_{jk}/\beta}^{p_{jk}} X_{jk}\left(u\right) du$ is the producer surplus for good k in country j; $t_{jk} = 0$ if $k = j$, as before; WCS is the weight on consumer surplus, WPS is the weight on producer surplus, and WTI is the weight on tariff income.

Given the tariff rates of other countries, in order to find its optimal tariff rates (i.e., the best response function), each country j maximizes Equation 2.1 with respect to t_{jk}'s for each good $k \in \{1, \ldots N\}$. Therefore, once we change what is given as the tariff rates of other countries, we can investigate various cases by considering the best response of a country. For example, if we would like to calculate Nash tariff rates under the case of no trade agreements, each country will obtain its best response function by taking the tariff rates of other countries as given in its welfare-maximization problem. As another example, if a group of countries get involved in a free trade agreement (e.g., a bilateral trade agreement), we can set the given tariff rates between these countries equal to zero (consistent with Article XXIV of the GATT) and calculate the best response functions of all countries accordingly in the welfare-maximization problem. We will employ such examples while comparing the likelihood of having free trade agreements under different scenarios, below.

3. The Stationary Dynamic Tariff Game

It is well known that repeated interactions between parties can be used to support payoffs that Pareto dominate those obtained in a one shot game. Accordingly, we consider countries playing an infinitely repeated game for tariff rates in this section. The repeated structure of the game gives more flexibility to our model in terms of incorporating the self-enforcement agreements. In this game, each country is able to compare future payoffs out of a possible collusion (cooperation) and out of a possible deviation from an FTA. [5]

When there are no agreements (i.e., when there are Nash tariff rates), country j gets a welfare of $W_j^N = W_j\left(t_{jk}^B, t_{kj}^B, t_{(-i)j}^B, t_{(-i)k}^B\right)$ that can be calculated by inserting arguments (of tariff rates) that maximize Equation 2.1 back into it, where t_{jk}^B and t_{kj}^B are the optimal Nash tariff rates between country j and country k, and $t_{(-i)j}^B$ ($t_{(-i)k}^B$) represents the optimal Nash tariff rate of all other countries on good j (resp., k). In the context of a bilateral FTA, country j's welfare when it makes a bilateral FT**A** with country k is represented by $W_j^A = W_j\left(t_{jk}^A, t_{kj}^A, t_{(-i)j}^B, t_{(-i)k}^B\right)$ where t_{jk}^A and t_{kj}^A are the agreed tariff rates for good j and k (which are equal to zero in our paper since we focus on FTAs), respectively, and $t_{(-i)j}^B$ ($t_{(-i)k}^B$) is the optimal tariff rates of all other countries on good j (resp., k) that can be obtained by Equation 2.1, given t_{jk}^A and t_{kj}^A. If country j **c**heats on country k, country j sets its optimal tariff rate on good k, t_{jk}^B, given t_{kj}^A, $t_{(-i)j}^B$ and $t_{(-i)k}^B$; i.e., country j maximizes $W_j^C = W_j\left(t_{jk}^B, t_{kj}^A, t_{(-i)j}^B, t_{(-i)k}^B\right)$. In this game, countries follow a grim trigger strategy, i.e., if country j cheats on country k in a particular period, then, starting from the next period, both countries set their optimal Nash tariff rates, and no agreement can be formed in the future.

We focus on sustainable FTAs. In order to sustain collusion in a trade agreement, the trade-off between the gains from deviating from an agreed-upon tariff policy and the discounted expected future gains from collusion must be balanced in a way that the latter should keep away countries from deviating. That is,

$$\frac{1}{1-\delta_j} W_j^A \geq W_j^C + \frac{\delta_j}{1-\delta_j} W_j^N$$

[5] Although this paper investigates FTAs, which account for over ninety percent of existing agreements in the world (see Freund and Ornelas, 2010), the model of this paper can easily be extended to investigate custom unions by redefining the welfare function and by determining which tariff rates are taken as given in the calculation of best responses.

where $0 < \delta_j < 1$ is the discount factor of country j.[6] Hence, country j cooperates if and only if

$$\left(\frac{\delta_j}{1-\delta_j}\right)\Psi_j - \Omega_j \geq 0 \tag{3.1}$$

or equivalently

$$\delta_j \geq \frac{\Omega_j}{\Psi_j + \Omega_j}$$

where Ψ_j is the one-period value of cooperation for country j, i.e.,

$$\Psi_j = W_j^A - W_j^N$$

and Ω_j is the welfare gain of country j from cheating to country k, i.e.,

$$\Omega_j = W_j^C - W_j^A$$

In other words, for country j to have a cooperation, the minimum discount factor of country j should be:

$$\underline{\delta}_j = \frac{\Omega_j}{\Psi_j + \Omega_j} \tag{3.2}$$

In our analysis, in order to talk about the likelihood of an FTA, we will consider the maximum of the minimum discount factors across countries involved in that FTA:

$$\underline{\delta} = \max\left\{\underline{\delta}_j\right\} \text{ for } j \in F \tag{3.3}$$

where F is the set of countries involved in that FTA. If $\underline{\delta}$ increases (decreases), the range of the discount factor within which an FTA is sustainable decreases (increases), and, hence, the likelihood of that FTA decreases (increases).[7]

In the context of a multilateral FTA, country j's welfare when it makes a multilateral FT**A** is represented by $W_j^A = W_j\left(t_{(-i)j}^A, t_{j(-i)}^A\right)$ where $t_{(-i)j}^A$ and $t_{j(-i)}^A$ represent the agreed zero tariff rates between country j and all other countries. If country j **c**heats on a multilateral FTA, it sets its optimal tariff rate on good all goods $t_{j(-i)}^B$, given $t_{(-i)j}^A$; i.e., country j maximizes $W_j^C = W_j\left(t_{(-i)j}^A, t_{j(-i)}^B\right)$. In the context of a multilateral FTA, as in the bilateral FTA case, countries again follow a grim trigger strategy; i.e., if country j cheats on all other countries in a particular period, then, starting from the next period, all countries set their optimal Nash tariff rates to each other, and no agreement can be formed in the future. In this multilateral FTA game, we will allow only one country to cheat for simplicity; therefore, Equations 3.2 or 3.3 can be used to investigate both sustainable bilateral FTAs and a sustainable multilateral FTA.

[6] Having a unique discount factor across all countries would result in the very same implications; nevertheless, we keep them country specific to show how each country is affected in the repeated game in a transparent way.

[7] Although we do not use the concept of "likelihood" in a statistical way, one can easily use it in such a way by assuming that $\underline{\delta}$'s have a standard uniform distribution.

4. A 3-Country-3-Good Example of the Stationary Dynamic Tariff Game

We would like to pursue an analysis of counterfactuals by considering the effects of trade costs, country sizes, and comparative advantages on the formation of FTAs. Since the model is highly stylized (through simplifying assumptions to have a tractable framework), these counterfactuals may not correspond to definitive policy analysis; nevertheless, they will provide insight into the workings of our model, which is representative of studies based on self-enforcing rules in the literature (as discussed in details, above).

In order to keep things tractable, we focus on a 3-country-3-good version of our model. We have two options in terms of the presentation of counterfactuals; we can either present the policy implications of our model through closed-form expressions or go one step further by parameterizing the closed-form expressions so that we can focus on the implications of our model that are consistent with FTA observations in the data. We follow the second approach, because, given the model, we believe that it is the only way to have relevant policy implications that are consistent with the real world. Accordingly, we follow a hybrid approach by first calibrating the non-policy parameters (i.e., parameters other than the policy weights in the welfare function) without loss of generality and then by simulating/estimating the policy parameters (i.e., WCS, WPS, and WTI) such that the implications of the model will match with the bilateral FTA observations in the data.

4.1. Parametrization through Minimum-Discount-Factor Analysis

We start with calibrating the non-policy parameters of A, B, β, λ_j (for all j) and α_{jk} (for all j,k). Without loss of generality, we calibrate these parameters such that (i) they satisfy the assumptions of $A > 0$, $B > 0$, $\beta > 0$, $\alpha_{jk} \leq 0$ and $\alpha_{kk} - \alpha_{jk} > (\beta + B)(t_{jk} + \tau_{jk})$; (ii) we have enough parameter space to perform different counterfactuals based on changes in transport costs, country sizes, and comparative advantage; and (iii) we have a simple and tractable presentation of the model. The benchmark values of calibrated parameters are given in Table 1, where τ_{jk}'s, λ_j's and α_{jk}'s are subject to change during the counterfactual analysis.

Given the calibrated parameters, we estimate the policy weights of WCS, WPS, and WTI such that (i) the bilateral-FTA implications of our model match with the empirical findings of Baier and Bergstrand (2004; BB, henceforth) that are consistent with 85% of the 286 bilateral FTAs existing in 1996 among 1431 pairs of countries and 97% of the remaining 1145 pairs with no bilateral FTAs, and (ii) the implied minimum discount factors $\underline{\delta}_j$'s (calculated by Equation 3.2) range between 0 and 1 to perform a healthy analysis. We achieve our estimation through a global grid search by considering every possible value for each of our policy weights (WCS, WPS, and WTI) between 0 and 1 by assuming, without loss of generality, that their summation is equal to 1 (i.e., $WCS + WPS + WTI = 1$).

Getting into more details, recall that, according to BB, the potential welfare gains and likelihood of a bilateral FTA are economically and significantly higher:

1. The closer in distance are two trading partners.

2. The more remote a natural pair is from the ROW.

3. The larger and more similar economically are two trading partners.

4. The greater the difference in comparative advantages (measured by capital-labor ratios).

5. The less is the difference in comparative advantages of the member countries relative to that of the ROW.

Therefore, given the calibrated parameters in Table 1, we search for policy weights (WCS, WPS, and WTI) that are consistent with all of these empirical findings. This requires connecting the concepts of distance, economic size, and comparative advantage to the relevant concepts in our model. Accordingly, in our model, we connect distance to iceberg transportation costs τ_{jk}'s, economic size to relative size of countries λ_j's, and capital-labor ratio to the comparative advantage measures of α_{jk}'s. Using the calibrated parameters in Table 1, we achieve counterfactuals for each and every possible value of WCS, WPS, and WTI between 0 and 1, and whenever our counterfactuals match with the empirical findings of BB, we accept the corresponding values of WCS, WPS, and WTI as our estimates.

Further details of each counterfactual analysis used in the estimation of the policy weights will be depicted in the following subsections; nevertheless, for presentational purposes, we here depict the estimation results in advance. The grid search results in WCS estimates ranging between 0.01 and 0.07, WPS estimates ranging between 0.71 and 0.77, and a unique WTI estimate of 0.22.[8] In more technical terms, these are the only values of WCS, WPS, and WTI that result in the counterfactuals (that are consistent with the empirical findings of BB) in Figures 1, 3 and 5 to be introduced and discussed, below. Given the model and the calibrated parameters in Table 1, these "estimated" values correspond to the average policy weights across countries in the sample of BB. As is evident, the policy weight given to the consumer surplus is much higher than the other weights. In order to keep things simple, we will use the median of these estimates in our investigation; i.e., $WCS = 0.04$, $WPS = 0.74$, and $WTI = 0.22$. It is important to emphasize that our results are virtually the same if we use other estimated values of the policy weights, which are very close to each other anyway.[9]

[8] Since $WCS + WPS + WTI = 1$ and $WTI = 0.22$, having, say, $WCS = 0.01$ corresponds to having $WPS = 0.77$, and so forth.

[9] The implications of alternative estimated parameters can be tested easily by using to-be-published Matlab codes.

4.2. FTAs and Transportation Costs

Our first goal is to show that the bilateral FTA implications of our model are consistent with the first two empirical findings of BB under the calibration in Table 1 and the corresponding estimates of the policy weights. Then, we will focus on the global welfare gains of possible FTAs through investigating the effects of transportation costs on the globally-sustainable-Pareto-optimal trade agreements (to be defined below).

4.2.1. The Minimum Discount Factor Analysis

The effects of transportation costs on the minimum discount factors to have a cooperation are given in Figure 1. The exercise we have in Figure 1 is to increase the transportation costs between Country 1 and the ROW (i.e., τ_{j1} and τ_{1j} for $j = 2, 3$) by keeping all other parameters the same as in Table 1 (e.g., the transport costs between Countries 2&3 are zero, $\tau_{23} = \tau_{32} = 0$). We measure the transportation costs as a percent of Country 1 source price of good 1 under no trade agreements (i.e., Nash tariff rates).

As is evident, as Country 1 gets more remote, the minimum discount factor (i.e., $\underline{\delta}$, the maximum of the minimum discount factors across countries) to have a distant bilateral FTA between Countries 1&2 or 1&3 increases, which means that the range of the discount factor, and, hence, the likelihood of a distant bilateral FTA decreases. This result is consistent with the first empirical finding of BB, above. The intuition is simple: Nash tariff rates (in the case of no trade agreements) are higher for closer countries, because closer countries get involved in more trade between each other that result in higher tariff incomes. Accordingly, if closer countries get involved in an FTA, their gain from reducing their bilateral tariff rates would be much higher compared to reducing their tariff rates with a remote country.

As is also evident in Figure 1, as Country 1 gets more remote, the minimum discount factor $\underline{\delta}$ to have a regional bilateral FTA between Countries 2&3 decreases, which means that the range of the discount factor, and, hence, the likelihood of a regional bilateral FTA increases. This result is consistent with the second empirical finding of BB, above, and can again be connected to the gains that can be obtained through reducing bilateral tariff rates between nearby countries.

4.2.2. Globally-Pareto-Optimal-Sustainable Trade Agreements

Although we have shown the minimum discount factors to have a cooperation across countries, we have not talked about the best alternative (i.e., Pareto optimal) trade agreements that are globally sustainable. In order to do that, we will focus on the global/world welfare defined as sum of the welfare of all three countries (i.e., $\sum_j W_j$) in Figure 2 by using the same parametrization as in Figure 1. The top panel of Figure 2 shows the welfare gains of the world defined as the one-period (which is proportional to lifetime) percentage welfare improvements of the world from an FTA. As is evident, independent of transport costs between Country 1 and the ROW, having a multilateral agreement is always the first-best solution, while having two bilateral FTAs, with one of the nearby countries (Country 2 or Country 3) being the hub, is the second-best solution from a global social planner's point of view.

Using the global welfare as our decision criteria, we can obtain globally-sustainable-Pareto-optimal trade agreements in the bottom panel of Figure 2, which is another representation of Figure 1. Since this is the first time that we are introducing the concept of globally-sustainable-Pareto-optimal trade agreements, it requires further explanation in technical terms. Specifically, we take Figure 1, and we search for the welfare maximizing trade agreements among sustainable trade agreements (or the case of "no agreement" if all the minimum discount factors are greater than zero) for each point in that graph. For instance, since a multilateral FTA is the first-best solution, the area above the minimum discount factor line for a multilateral FTA in Figure 1 indicates the area of a multilateral FTA that is globally-sustainable-Pareto-optimal. Once the area above the minimum-discount-factor line for a multilateral FTA is assigned to a globally-Pareto-optimal-sustainable multilateral FTA, we are left with two areas in the graph; one between the minimum-discount-factor lines for a regional bilateral FTA and a multilateral FTA, the other between a regional bilateral FTA and the x-axis. Regarding the former area, the welfare gains are higher than zero but lower than the gains from a multilateral FTA according to the top panel of Figure 2; hence, this area will be assigned to a globally-Pareto-optimal-sustainable regional bilateral FTA. Regarding the latter area, it does not coincide with any trade agreements in Figure 1; therefore, this area will represent no trade agreements.

As is evident at the bottom of Figure 2, higher transport costs facilitate regional bilateral FTAs, and lower transport costs, in relative terms, facilitate a multilateral FTA from a social planner's point of view. Unfortunately, a multilateral FTA maximizing the global welfare for any transport cost is the hardest to sustain due to self-enforcement issues. Nevertheless, the different globally-welfare-maximizing FTAs have closer minimum discount factors as there are fewer transport costs between Country 1 and the ROW. Hence, the existence of transport costs is one of the obstacles for having a multilateral FTA according to this analysis, meaning that if we can reduce transport costs (e.g., through investing in transportation technologies), the likelihood of forming a multilateral FTA will increase in a global context.

4.3. FTAs and Country Sizes

This subsection will first show that the bilateral FTA implications of our model are consistent with the third empirical finding of BB under the calibration in Table 1 and the corresponding estimates of the policy weights. Then, we will focus on the effects of country sizes on globally-sustainable-Pareto-optimal trade agreements.

4.3.1. The Minimum Discount Factor Analysis

The effects of country sizes on the minimum discount factors to have a cooperation are given in Figure 3. For our counterfactuals, we have to find a way to consider both sizes (in magnitude) and similarities (in size) of countries at the same time to test for the third empirical finding of BB. Accordingly, the exercise we have in Figure 3 is to increase the sizes of Country 2 and Country 3 (i.e., λ_2 and λ_3) at different amounts (where λ_2 is depicted at the bottom x-axis and λ_3 is depicted at the top x-axis) by keeping all other parameters the same as in Table 1 (e.g., $\lambda_1 = 1$). As is evident, as Country 2 and Country 3 get larger and more similar economically (i.e., as they approach having exactly the same size of $\lambda_2 = \lambda_3 = 2$), the (global) minimum discount factor $\underline{\delta}$ to have a bilateral FTA between Countries 2&3 decreases, which means that the range of the discount factor, and, hence, the likelihood of a bilateral FTA increases. In particular, the left of $\lambda_2 = \lambda_3 = 2$ in the x-axes show a higher likelihood of having a bilateral FTA when Country 2 and Country 3 get larger, while the right of $\lambda_2 = \lambda_3 = 2$ in the x-axes show a higher likelihood of having a bilateral FTA when Country 2 and Country 3 get more similar in terms of their sizes (independent of the magnitude of their sizes). This result is consistent with the third empirical finding of BB, above, and can be connected to the high Nash tariff rates between larger and economically more similar countries due to the having more trade between each other resulting in higher tariff incomes.[10] Therefore, if larger and economically similar countries get involved in an FTA, their gain from reducing their bilateral tariff rates would be much higher compared to reducing their tariff rates with a smaller country.

4.3.2. Globally-Pareto-Optimal-Sustainable Trade Agreements

The top panel of Figure 4 shows the welfare gains of the world again defined as the one-period (which is proportional to lifetime) percentage welfare improvements of the world from an FTA by using the parametrization as in Figure 3. As is evident, having a multilateral agreement is again the first-best solution for all considered sizes of countries, while having two bilateral FTAs, with one of the large countries (Country 2 or Country 3) being the hub, is the second-best solution from a global social planner's point of view. Using the global welfare as our decision criteria, we obtain globally-sustainable-Pareto-optimal trade agreements in the bottom panel of Figure 4, which is another representation of Figure 3. As is evident, lower country size differences between Countries 2 and 3 facilitate bilateral FTAs from a social planner's

[10] When we consider the case when the sizes of Country 1 and Country 2 are very similar to each other (i.e., when λ_2 is close to $\lambda_1 = 1$), a bilateral FTA between these countries has the highest likelihood, which is another result supporting the empirical power of our model.

point of view. As in the case of transportation costs, a multilateral FTA maximizing the global welfare for any country size is the hardest to sustain due to self-enforcement issues. Nevertheless, a globally-welfare-maximizing multilateral FTA has a lower minimum discount factors as larger countries converge to each other in terms of their sizes (e.g., when $\lambda_2 = \lambda_3 = 2$). Hence, according to our analysis, the existence of country size differences is another obstacle for having a multilateral FTA, meaning that once countries will converge to each other in terms of their sizes (e.g., through catch-up effects that are mostly possible when countries are stable in terms of their economic indicators such as inflation, financial development, and government size as highly documented by the growth literature), the likelihood of forming a multilateral FTA will increase in a global context.

4.4. FTAs and Comparative Advantage

This subsection will first show that the bilateral FTA implications of our model are consistent also with the last two empirical findings of BB under the calibration in Table 1 and the corresponding estimates of the policy weights. Then, we will focus on the effects of comparative advantage on the globally-sustainable-Pareto-optimal trade agreements.

4.4.1. The Minimum Discount Factor Analysis

The effects of comparative advantage on the minimum discount factors to have a cooperation are given in Figure 5. In order to show the consistency of our counterfactual with the empirical findings of BB, we have to find a way to consider both differences in comparative advantage among member countries and differences in comparative advantage between the member countries and the ROW (i.e., a way that will control for the magnitude of α_{jj}'s while comparing their differences). Accordingly, the exercise we have in Figure 5 is to play with the comparative advantage of both Country 2 and Country 3 by different amounts, while keeping all other parameters the same as in Table 1 (including the comparative advantage of Country 1 kept as $\alpha_{11} = -1$). In particular, we start the comparative advantage parameter for Country 2 from $\alpha_{22} = -0.2$ and decrease it to $\alpha_{22} = -2.2$ along the way, and at the same time, we start the comparative advantage parameter for Country 3 from $\alpha_{33} = -2.2$ and increase it to $\alpha_{33} = -0.2$ along the way.[11] Therefore, we would like to have the minimum discount factor $\underline{\delta}$ to have a bilateral FTA between Countries 2&3 having a concave shape in the following expression

[11] Hence, as we move from left to the right on the x-axis, (a) comparative advantage of Country 2 decreases, (b) the comparative advantage of Country 3 increases, (c) the comparative advantage difference between Country 1 and Country 2 increases, (d) the comparative advantage difference between Country 1 and Country 3 decreases, and (e) the comparative advantage difference between Country 2 and Country 3 first decreases, then increases.

(adapted from BB):

$$\frac{|(\alpha_{11} - \alpha_{22})| + |(\alpha_{11} - \alpha_{33})|}{2}$$

where $|\cdot|$ stands for absolute value. The idea is to have a lower probability of a bilateral FTA between Countries 2&3 when the (absolute) difference between α_{jj}'s of Countries 2&3 and α_{jj} for the rest of the world (i.e., α_{11}) is wider. As is evident in Figure 5, as we move toward the edges of the x-axes (i.e., as there are greater differences across countries in comparative advantages), the minimum discount factor $\underline{\delta}$ to have a bilateral FTA between Countries 1&2 or 1&3 decreases, which means that the range of the discount factor, and, hence, the likelihood of a bilateral FTA increases. This result is consistent with the fourth empirical finding of BB, above, and can be connected to the high Nash tariff rates between countries that have higher comparative advantage differences due to high trade volumes resulting in higher tariff incomes. In particular, if countries that have higher comparative advantage differences get involved in an FTA, their gain from reducing their bilateral tariff rates would be much higher compared to reducing their tariff rates with a similar country in terms of comparative advantage.

As is also evident in Figure 5, as Country 2 approaches the same comparative advantage as Country 3 when $\alpha_{22} = \alpha_{33} = -1.2$ (i.e., when there are fewer difference in comparative advantages of the member countries relative to that of the ROW), the minimum discount factor $\underline{\delta}$ to have a bilateral FTA between Countries 2&3 decreases, which means that the range of the discount factor, and, hence, the likelihood of a bilateral FTA increases. This result is consistent with the fifth empirical finding of BB, above. Notice that we do not see the discount factor having a lower value as the comparative advantage of Country 2 or Country 3 (α_{22} or α_{33}) approach to the comparative advantage of Country 1 (a_{11}); this is because the magnitude of the increase in likelihood of a bilateral FTA due to the larger difference in comparative advantages (as we move toward the edges of the x-axes) is higher than the one due to having smaller differences in comparative advantages of the member countries relative to that of the ROW (as we move toward $a_{11} = a_{22}$ or $a_{11} = a_{33}$).

4.4.2. Globally-Pareto-Optimal-Sustainable Trade Agreements

The top panel of Figure 6 shows the welfare gains of the world defined as the one-period (which is proportional to lifetime) percentage welfare improvements of the world from an FTA. As is evident, as we have closer comparative advantages across countries (i.e., as we move toward the middle of the x-axes), having a multilateral FTA is again the first-best solution, while having two bilateral FTAs is the second-best solution, and having a bilateral FTA is the worst solution from a global social planner's point of view. Using the global welfare as our decision criteria, we can obtain globally-sustainable-Pareto-optimal trade agreements in the bottom panel of Figure 6, which is another representation of Figure 5. As is evident, higher comparative advantage differences across countries (moving toward the edges of the x-axes) facilitate bilateral FTAs, and lower comparative advantage differences (moving toward $\alpha_{22} = \alpha_{33} = -1.2$), in relative terms, facilitate a multilateral FTA that is still the hardest to sustain due to self-enforcement issues. Hence, the existence of comparative advantage differences is another obstacle for having a multilateral FTA according to our model, meaning that once countries will converge to each other in terms of their comparative advantages (e.g., through diffusion of technology across countries), the likelihood of forming a multilateral FTA will increase in a global context.

5. Conclusion

This paper has investigated the globally-sustainable-Pareto-optimal trade agreements through an infinitely repeated-game framework in a partial-equilibrium trade model considering transportation costs, country sizes, and comparative advantages. There are three main contributions: (1) Given the model and calibrated non-policy parameters, we estimate the policy weights on consumer surplus, producer surplus, and tariff income by considering the counterfactuals of the model that are consistent with the empirical findings of Baier and Bergstrand (2004) regarding bilateral FTAs; we show that the weight on producer surplus is much higher than the others. To our knowledge, this is the first study estimating such policy weights in a model with self-enforcing rules. (2) We show that although a multilateral FTA is the first-best solution globally, bilateral FTAs are the agreements that are globally-sustainable-Pareto-optimal for a wider range of parameters, while a welfare maximizing multilateral FTA is globally-sustainable-Pareto-optimal only for very special cases (i.e., when we have very high minimum discount factors); therefore, a multilateral FTA is hard to sustain due to self-enforcement issues. (3) We show that transportation costs, country size differences, and comparative advantage differences across countries all contribute to having bilateral rather than multilateral FTAs. Hence, in terms of global policy implications, possible ways to increase the likelihood of a self-enforcing multilateral FTA are all based on reducing asymmetries across countries: e.g., (i) to invest in transportation technologies, (ii) have underdeveloped countries to catch-up with developed countries through pushing for their economic stability, and (iii) share technological improvements around the world, say, through patent agreements across countries, or through encouraging foreign direct investments from high-technology countries.

Nevertheless, our analysis is not without caveats. For example, we have considered common welfare weights on consumer surplus, producer surplus, and tariff income across countries for simplicity, but considering country-specific welfare weights would result in richer comparative statics. In any case, such common policy weights are still very informative:

Given the model and parametrization in this paper, the estimated policy weights correspond to the average policy weights across countries in the bilateral FTA data used by BB. Therefore, they are consistent with internal political forces of the considered countries on average. Since it would be hard to change such internal political forces through international policies and/or negotiations, the success of forming a multilateral FTA (rather than bilateral FTAs) requires efforts that are more than what an individual government's trade policy can achieve. This explains why trade agreements are brought to international negotiation tables together with other political, cultural or historical benefits/conflicts. Therefore, in addition to Limao (2007), who investigates *preferential* agreements motivated by cooperation in non-trade issues, future research is required to focus on possible *multilateral* FTAs motivated by cooperation in non-trade issues.

Another caveat is that we have considered symmetric transport costs which are exogenously determined in the model; as Panagariya (1997) has suggested, they may not be different than any other (non-tariff) trade costs such as trade frictions (e.g., exporting costs), cultural ties or networks. Hence, in addition to investing in transportation technologies, working on eliminating trade frictions (as in gravity equations and/or as in Viner, 1950) or creating wider trade networks, together with self-improving global culturalism through advancing communication technologies, may also help increasing the likelihood of a multilateral FTA through time. Moreover, such non-tariff trade costs may be asymmetric as in Waugh (2010) between rich and poor countries due to asymmetric trade frictions between them. Considering such asymmetries, together with their interaction with country sizes and comparative advantages, remains as a future research topic.

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Table 1 - Benchmark Parameter Values and Variables

Calibrated Parameters	Definition	Benchmark Value
A	Intercept of Demand	4
B	Slope of Demand	1
α_{jj}	Intercept of Supply with Comparative Advantage	-1
α_{jk}	Intercept of Supply without Comparative Advantage	-3
β	Slope of Supply	1
λ_j	Relative Size of Country j	1

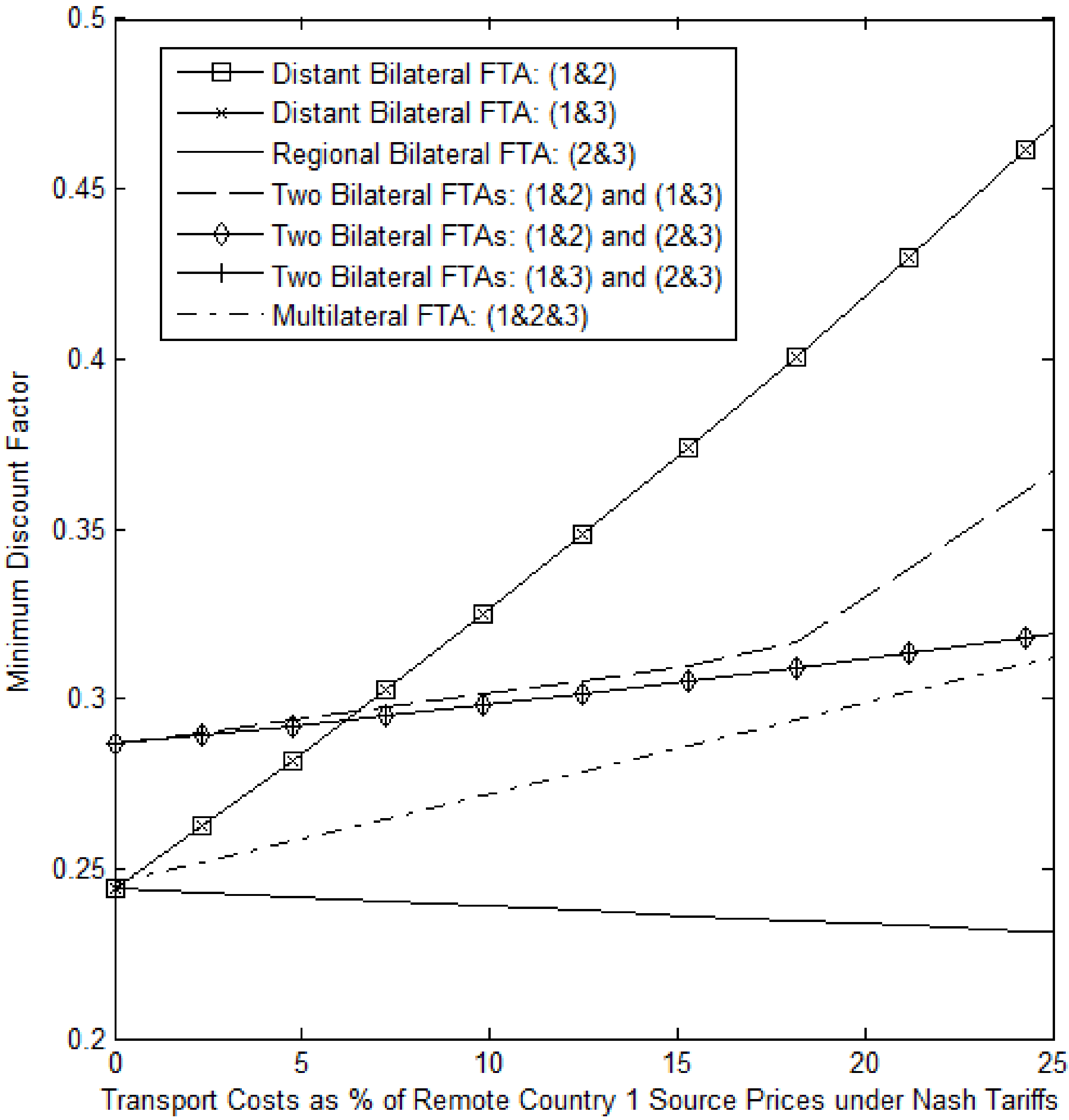
Estimated Parameters		Estimated Value
WCS	Weight on Consumer Surplus in Welfare	$0.01 - 0.07$
WPS	Weight on Producer Surplus in Welfare	$0.71 - 0.77$
WTI	Weight on Tariff Income in Welfare	0.22
δ_j	Discount Factor of Country j	Variable
$\underline{\delta}_j$	Minimum Discount Factor of Country j	Variable
$\underline{\delta}$	The Maximum of the Minimum Discount Factors	Variable

Exogenous Variables	Definition	Benchmark Value
τ_{jk}	Transport Costs between Countries j and k	0
t_{jk}^A	Agreed Tariff of Country j on Country k	0

Endogenous Variables	Definition
D_{ji}	Demand for Good i in Country j
X_{ji}	Supply of Good i in Country j
p_{ji}	Price of Good i in Country j
M_{jk}	Imports of Country j from Country k
W_j	Wealth of Country j
t_{jk}^B	Best Response Tariff of Country j on Country k, given Others' Tariffs
t_{jk}^N	Nash Tariff Imposed by Country j on Country k
Ψ_j	One-Period Gain of Cooperation
Ω_j	One-Period Gain of Cheating

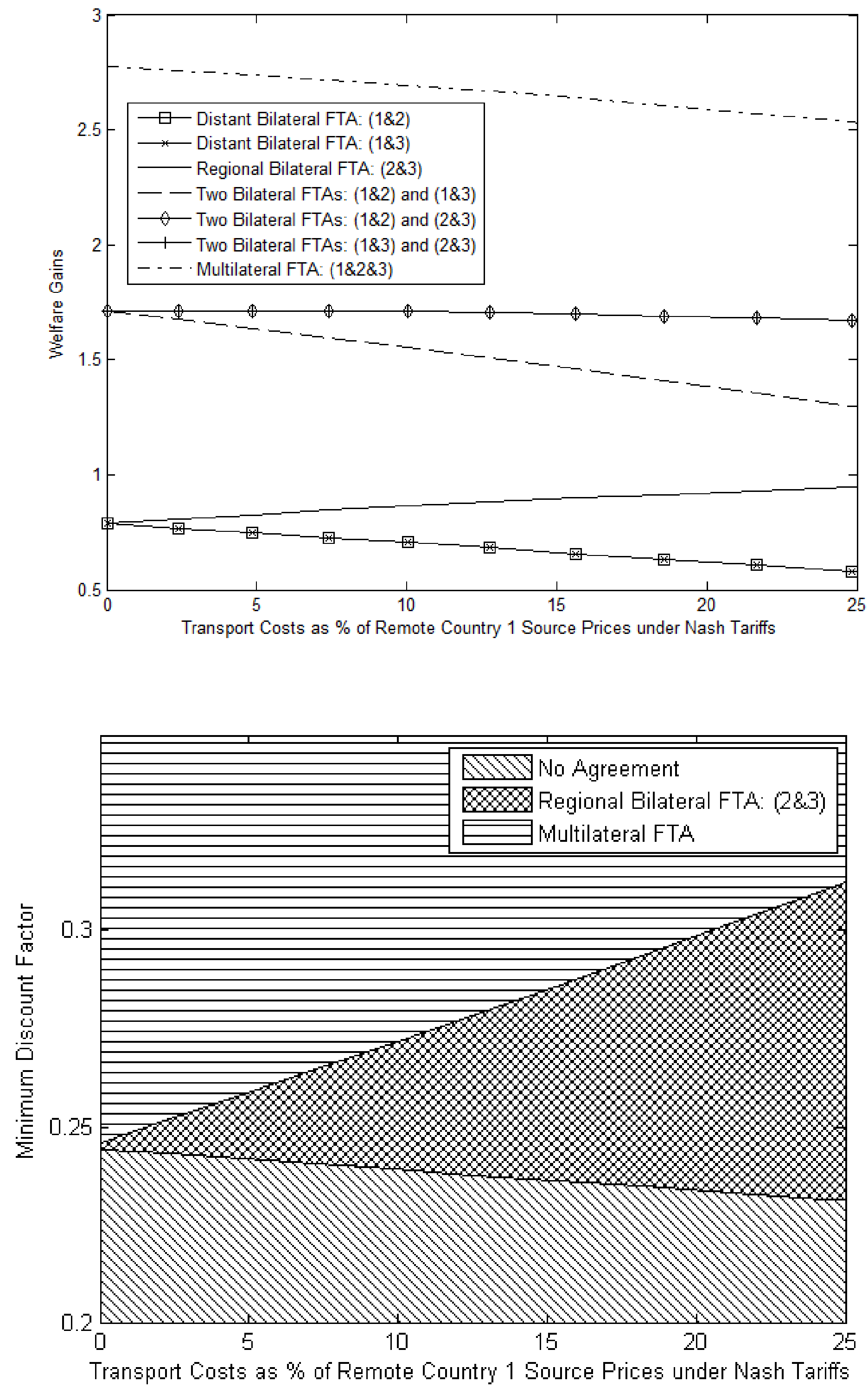
Notes: "Variable" stands for values determined by different versions of the model.

Figure 1 - Transport Costs and Sustainability of Trade Agreements



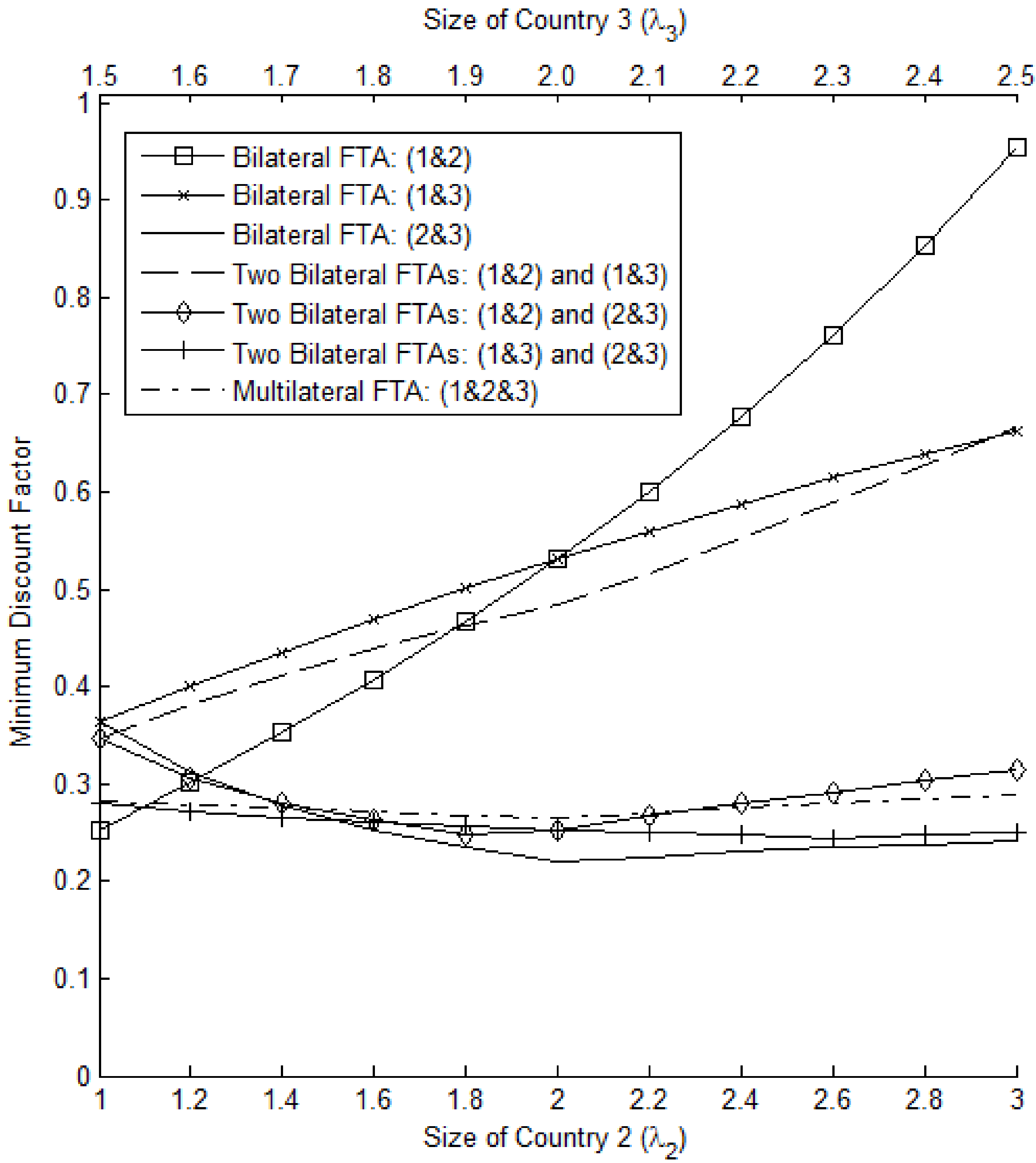
Notes: Country 1 is the one for which the transport costs of its exports and imports are increased. For each line, minimum discount factors have been calculated as the maximum of the minimum discount factors of the countries involved in the agreement.

Figure 2 - Transport Costs, Global Welfare Gains, and Globally-Sustainable-Pareto-Optimal Trade Agreements



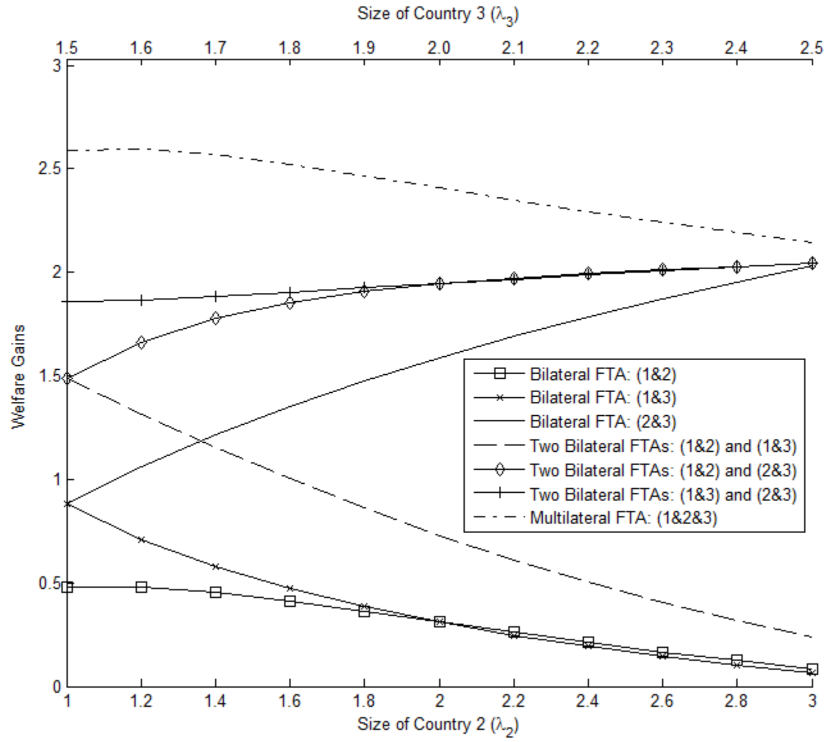
Notes: The top figure shows the welfare gains of the world (calculated as the sum of the welfare gains of the three countries) in a one-shot environment (which is proportional to lifetime welfare gains at a particular discount factor). The bottom figure shows the globally-Pareto-optimal-sustainable trade agreements. Although the maximum (minimum) of the minimum discount factor has been set to 0.35 for presentational purposes, multilateral FTA (no agreement) is globally-Pareto-optimal-sustainable for minimum discount factors between 0.35 and 1.0.

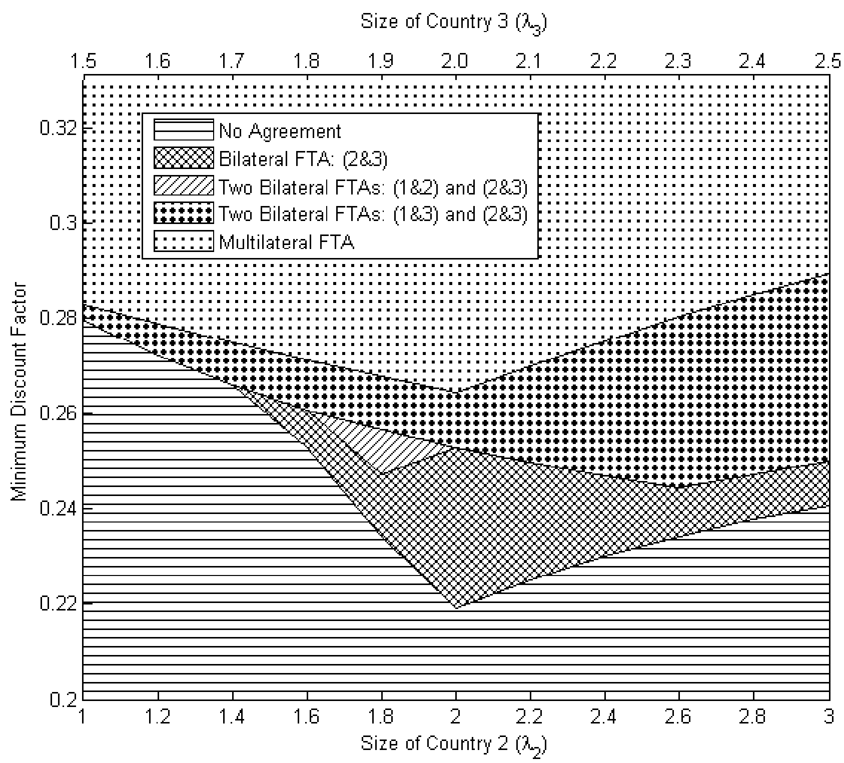
Figure 3 - Country Sizes and Sustainability of Trade Agreements



Notes: Country 2 and Country 3 are the ones of which sizes are increased. For each line, minimum discount factors have been calculated as the maximum of the minimum discount factors of the countries involved in the agreement.

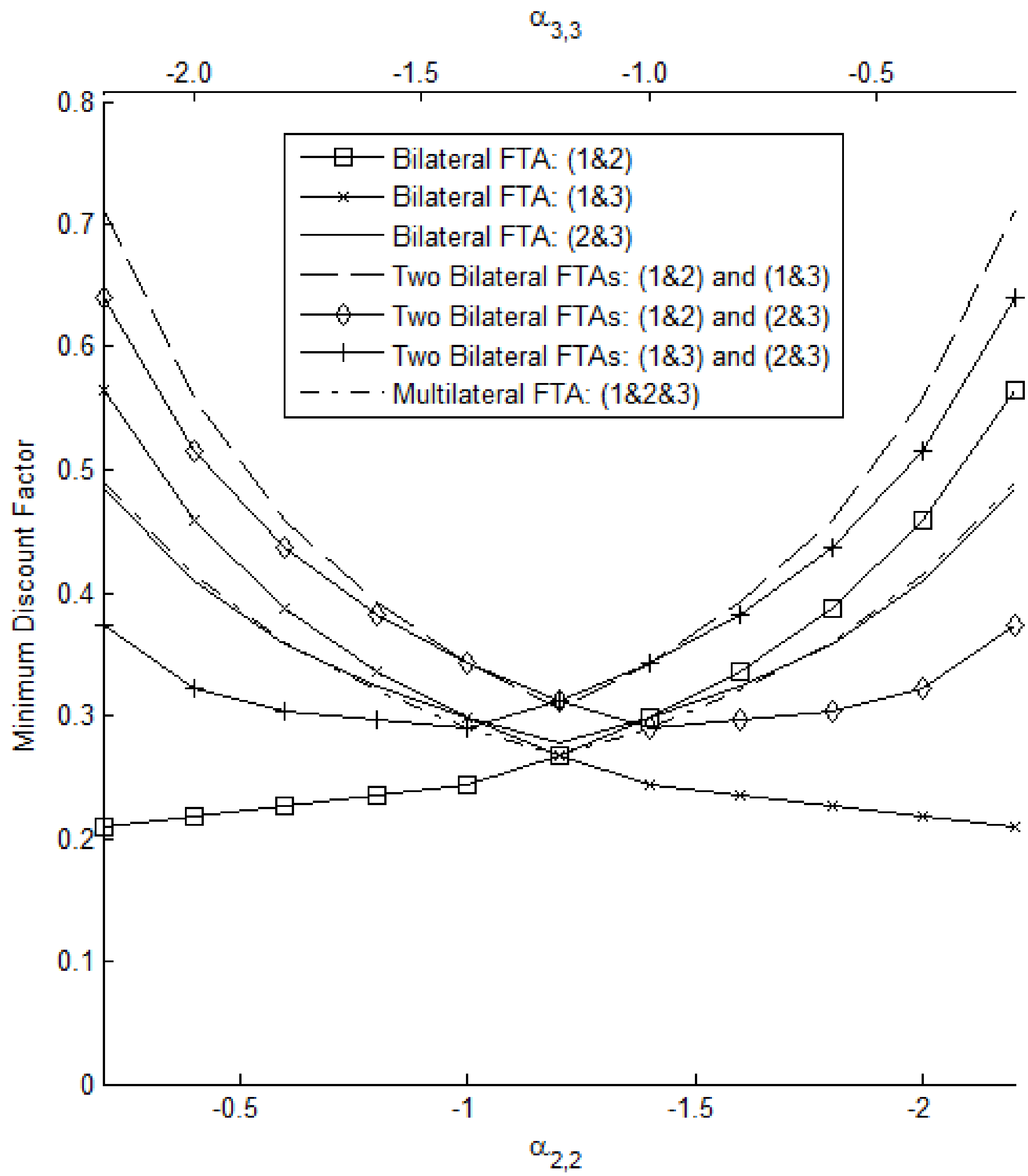
Figure 4 - Country Sizes, Global Welfare Gains, and Globally-Sustainable-Pareto-Optimal Trade Agreements





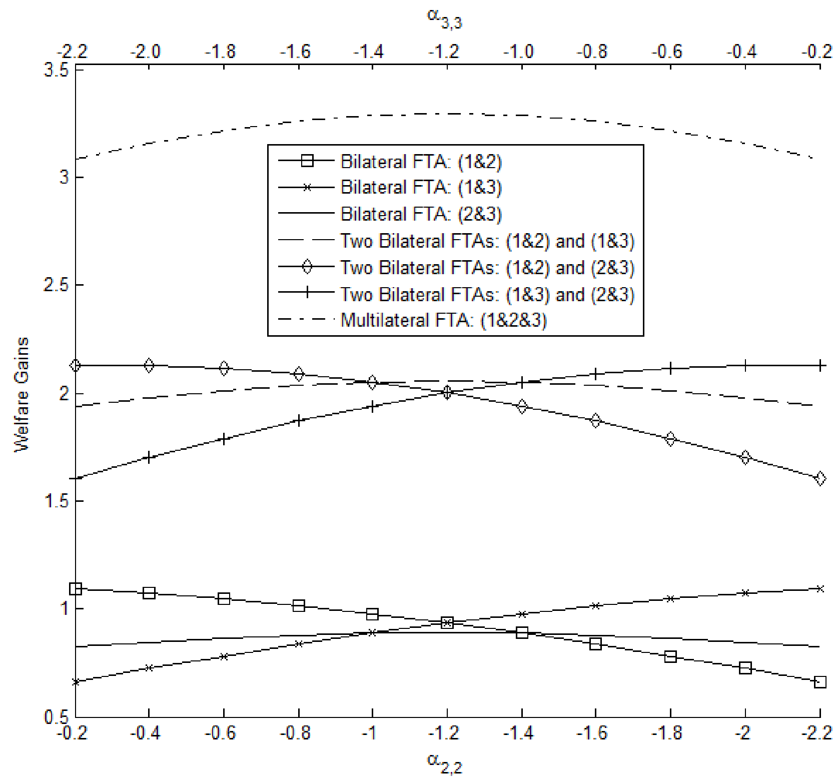
Notes: The top figure shows the welfare gains of the world (calculated as the sum of the welfare gains of the three countries) in a one-shot environment (which is proportional to lifetime welfare gains at a particular discount factor). The bottom figure shows the globally-Pareto-optimal-sustainable trade agreements. Although the maximum (minimum) of the minimum discount factor has been set to 0.33 (0.2) for presentational purposes, multilateral FTA (no agreement) is globally-Pareto-optimal-sustainable for minimum discount factors between 0.33 and 1.0 (0.0 and 0.2).

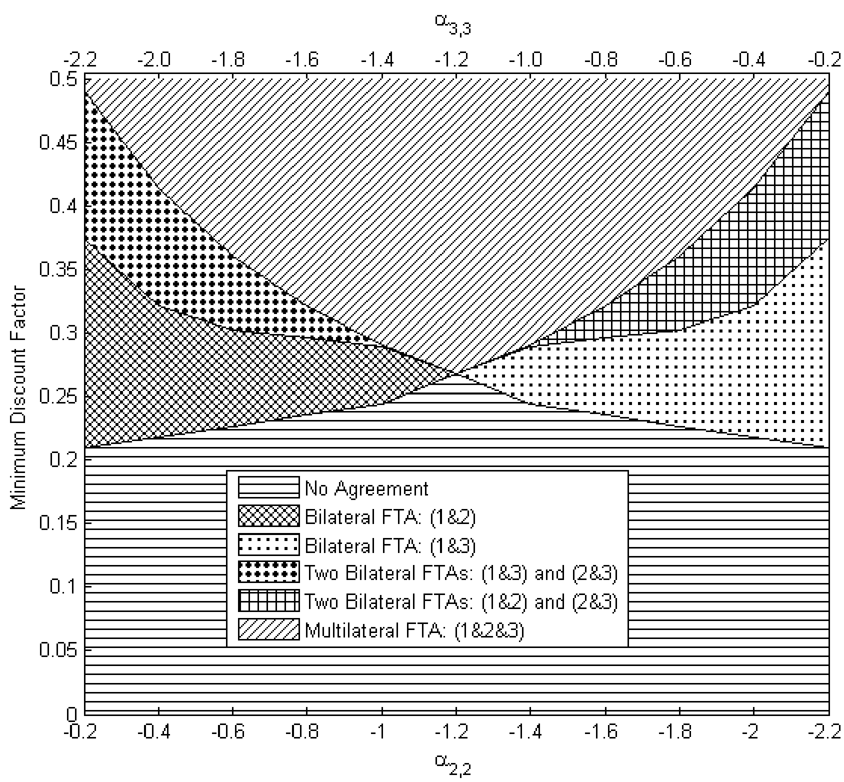
Figure 5 - Comparative Advantage and Sustainability of Trade Agreements



Notes: Country 2 and Country 3 are the ones of which comparative advantage measures are changed. For each line, minimum discount factors have been calculated as the maximum of the minimum discount factors of the countries involved in the agreement.

Figure 6 - Comparative Advantage, Global Welfare Gains, and Globally-Sustainable-Pareto-Optimal Trade Agreements





Notes: The top figure shows the welfare gains of the world (calculated as the sum of the welfare gains of the three countries) in a one-shot environment (which is proportional to lifetime welfare gains at a particular discount factor). The bottom figure shows the globally-Pareto-optimal-sustainable trade agreements. Although the maximum of the minimum discount factor has been set to 0.5 for presentational purposes, a multilateral FTA (no agreement) is globally-Pareto-optimal-sustainable for minimum discount factors between 0.5 and 1.0.